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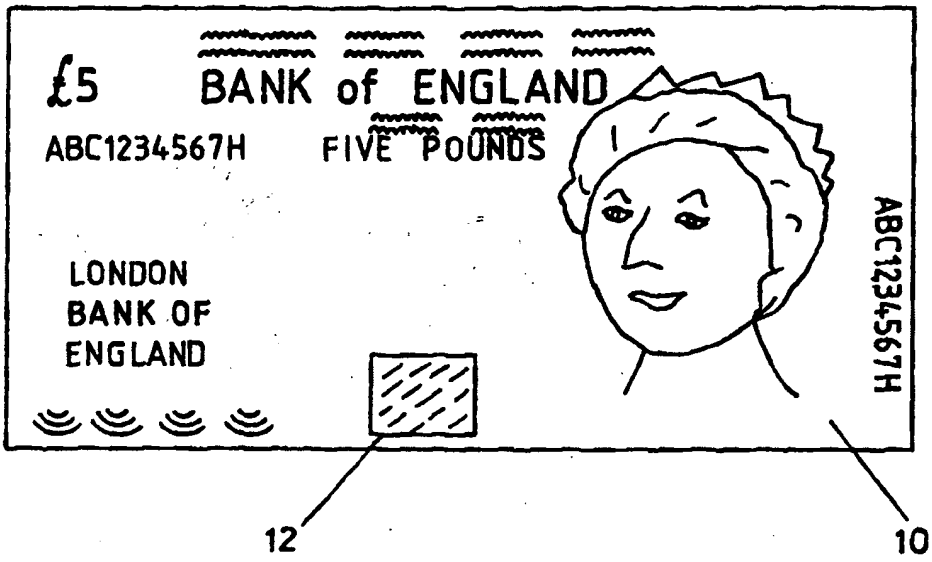
(54) Title: OPTICALLY VARIABLE DEVICES



(57) Abstract

A substrate, such as a banknote (10) or other document of value, is provided with a security feature in the form of an optically variable device (12), by a process which comprises applying a coating of an ink to a discrete area of the substrate (10) by a printing process, then impressing the ink coating using an impression die, to form a pattern of reflective grooves in the surface of the inked area, these reflective grooves forming an optically variable image under incident light.

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Optically variable devices

The present invention relates to optically variable devices and more particularly to a method of forming optically variable devices on substrates, especially on documents of value (e.g. banknotes). The invention is moreover particularly concerned with optically variable devices (OVD's) which depend solely on light reflection, not light diffraction.

Diffractive OVD's, including holograms and electron beam diffractive structures such as Kinegrams and Exelgrams, comprise a micro-fringe diffractive structure which produces either two-dimensional or three-dimensional variable images by the diffraction of light. Typically, diffractive OVD's have a fringe spacing of 0.1 to 1.5 microns.

For diffractive OVD's to work efficiently, a reflective layer is applied over the micro-fringe structure. Typically the most effective reflective layer comprises vacuum deposited aluminium: for certain security applications, it is preferred to use a coating of high refractive index, comprising a rare earth oxide.

Diffractive OVD's are being used increasingly to combat the illicit replication or alteration of documents or other articles. Banknotes and other high security, printed documents are of particular concern. Traditionally such documents have used intaglio print, speciality rag papers (incorporating watermarks, embedded threads or window threads) or devices such as fluorescent threads, planchettes or latent images. However, with the advent of relatively inexpensive computers, laser scanners and colour copies etc., banknotes and other documents of value have become open to counterfeit abuse, not only by organised criminals but also by the casual counterfeiter simply replicating several banknotes or documents at his local colour copier shop.

As a consequence, banknote printers are being forced to consider new technologies to secure their products against modern replication technology. Diffractive OVD's represent effective technology and several countries have adopted them, in the form of an aluminium-coated, hot foil stamp, which is

applied to the surface of the banknote. Although the device is effective in preventing illicit replication, the additional cost of applying the device to a banknote or other document is high, and indeed prohibitive in the case of banknotes of relatively low denominations. Moreover, the OVD in the form of a hot stamp foil is not particularly robust and the normal lifetime of the banknote will usually be reduced.

It is an object of the present invention to provide a method of providing a substrate with an optically variable device in a simple and inexpensive manner, to provide an effective security feature.

In accordance with the present invention, there is provided a process for forming a substrate with an optically variable device, the process comprising applying a coating of a composition to an area of a surface of said substrate and then impressing said coating of composition to form a pattern of reflective grooves in the surface of the composition, so as to provide an optically variable image under incident light.

It will be appreciated that the optically variable device may be formed in a discrete area only of the substrate surface. In the case of a banknote or other document of value (e.g. ticket, receipt, certificate etc.), the remainder of the substrate surface remains available for printed or written information, design features etc.

The optically variable image (i.e. such that the image seen by the viewer varies with the angle of view) may be arranged to depend solely on light reflection, without light diffraction. International patent application WO98/08131 and International patent application WO98/20382 disclose optically variable devices of this nature, the groove or ridge spacings being in the range 2 to 100 microns, such that there is no light diffraction, only light reflection effects. In particular, in WO98/08131, an OVD is disclosed in which a substrate is formed with a plurality of stereo pairs of reflective elements (particularly grooves or ridges), each stereo pair of such elements providing an image of a point at a predetermined distance from the plane of the substrate: the plurality of these point-images form a three-dimensional optical image; the arrangement produces images in three

dimensions with true parallax. In WO98/20382, an OVD is disclosed in which a substrate is formed with a plurality of groups of elemental areas, the different groups forming respective image pixels: the different elemental areas of each group are formed with respective sets of reflective grooves or ridges, with the grooves or ridges of the different elemental areas being at different orientations. This arrangement produces a two-dimensional optical kinetic image.

In such arrangements, all of the image is seen as reflected light and consequently the image replays in the colour of the light with which its pattern of grooves or raised ridges (herein referred to as "fringes" for convenience) is illuminated. For example, if the device is viewed under blue light, the image will be blue, whilst if the device is viewed under while light, the image will be white.

In the method of the present invention, preferably a composition (e.g. an ink) is selected which, when dry, has a high gloss surface finish. This ink or other composition can be printed onto the substrate surface, and then impressed with a metal stamper to form a surface relief pattern in the ink. The gloss surface to the grooves thus formed provides for reflection of incident light and the pattern of grooves is such as to provide a variable optical image. Preferably the colour of the ink contrasts strongly with the colour of the light under which the image is intended to be viewed: if white light is used to replay the image, then a white image will be seen, so that a black ink would then give maximum contrast and greatly enhance viewability of the image.

Suitable compositions include gloss intaglio inks, acrylic inks and water-based black gravure inks (e.g. Sicpa KS 80007S). Preferably the impressing die is pre-heated. Preferably the fringe aspect ratio (ratio of pitch: depth of the grooves formed in the ink surface) is 1:1, although ratios as low as 20:1 may be used. The thickness of the ink required is dependent on the fringe aspect ratio, depth of the fringes and the surface texture of the paper or other substrate on which it is printed.

Preferably 3 to 8 gms per square metre of ink is applied to the paper or other substrate. Preferably the area

of the paper to which the security feature is to be applied is super-calendared prior to printing. Alternatively, an initial coating may be applied to remove any surface irregularities, before a top coating of ink is applied and subsequently impressed. The initial coating may comprise an ink of the contrast colour, or different areas of different contrast colours to provide a printed background design. The top coating of ink may be transparent but with a high gloss surface finish.

Banknotes or other documents can be printed with their usual features of information and design etc. by normal off-set and/or intaglio printing processes. The optically variable ink patch can be applied by a number of different processes, including silk screen printing. The sheets of banknotes or other documents thus printed can then be offered to a rotary or platen press fitted with an impression plate to impress the optically variable fringe pattern into the surface of the ink patch. This allows the printing machinery to run at maximum speeds, and the process is of relatively low cost.

In a modified process, a background patch, of contrasting colour or colours, can be printed e.g. by off-set or intaglio printing, and then a positive relief is printed on top of this using a clear or transparent, high gloss ink: the latter ink is thus applied as a pattern of raised ridges on the pre-printed base coat, these ridges being reflective to provide the optically variable image. In some circumstances, such a pattern of ridges can be applied directly to the surface of the substrate, using ink of a colour (e.g. black) to contrast with the light under which the image is to be viewed. Again, the fringe spacings are in the range of 2 to 100 microns, such that there is no light diffraction, only light reflection effects.

Embodiments of the present invention will now be described by way of examples only and with reference to the accompanying drawings, in which:

FIGURE 1 is a schematic plan view of a banknote provided with a security feature, in the form of an optically variable device, by a process in accordance with the present invention;

FIGURES 2 and 3 are schematic diagrams for use in

explaining the principles according to which one form of OVD may be provided in accordance with the present invention; and

FIGURE 4 is a schematic diagram for use in explaining the principles according to which a second form of OVD may be provided in accordance with the present invention.

Referring to Figure 1, there is shown a banknote 10 having an optically variable device (OVD) 12 formed over a discrete area of one surface of the banknote. The same surface of the banknote carries printed information and distinctive artwork in conventional manner.

The OVD 12 is formed, in the example shown, by applying an ink as a coating over that discrete area, by a printing process. This ink is one which exhibits a high gloss surface finish when dry. This patch of ink is then impressed with an impression die, to form a pattern of reflective grooves in the surface of the ink patch, to provide an optically variable image under incident light.

The pattern of reflective grooves is arranged to provide the optically variable image by light reflection, without light diffraction. In accordance with the teachings of WO98/08131, the pattern of reflective grooves may comprise a plurality of stereo pairs of grooves, each pair of grooves providing the image of a point at a predetermined distance from (i.e. in front of or behind) the plane of the substrate on which the grooves are carried. For example, Figure 2 shows a stereo pair of short, linear grooves 20,22 oriented to form, by reflection of the incident light beam B, a point image P at a distance behind the substrate in which the grooves are formed: Figure 3 shows a similar stereo pair of grooves 24,26 oriented to form a point image P' at a distance in front of the substrate; in both cases, the distance of the point image (P or P') from the substrate is substantially equal to the distance r from each groove to the intersection of the lines normal to those grooves. The plurality of point images, provided by the plurality of stereo pairs of grooves, form a three-dimensional optical image, which varies according to the angle of view.

The pattern of reflective grooves may instead be arranged in accordance with the teachings of WO98/20382. In

this case, the security feature is made up of a plurality of groups of elemental areas, the different groups forming respective image pixels, with the different elemental areas of each group being formed with respective grooves or sets of grooves: the grooves of the different elemental areas of each group are at different orientations. Figure 4 shows one such group of elemental areas A_1 to A_n, each formed with a set of parallel grooves 32_1 to 32_n, but with the grooves of each such elemental area oriented at a different angle to the grooves of the preceding elemental area of the group. Thus, as the substrate, which carries these grooves, is turned through 180° in a counterclockwise direction, under incident light beam B, the successive elemental areas A_1 to A_n become visible to the viewer in turn one-at-a-time. The group forms one pixel of an image: the OVD comprises a plurality of such groups, forming a corresponding plurality of pixels making up an image; rotation of the substrate accordingly produces, in effect, a dynamic movement of the image.

It will be appreciated that, in accordance with the invention, banknotes or other documents of value are provided with an optically variable image using apparatus and techniques which are basically conventional to the security printing industry. Even the impressing of the ink patch can be carried out using conventional equipment. The process provides a highly secure optically variable device, which cannot be replicated by the use of laser scanning, colour photocopying or other known techniques. Moreover, the process involves relatively low cost and can therefore be used on all banknotes, including those of low denomination.

Claims

1) A process for forming a substrate with an optically variable device, the process comprising applying a coating of a composition to an areas of a surface of said substrate and then impressing said coating of composition to form a pattern of reflective grooves in the surface of the composition, so as to provide an optically variable image under incident light.

2) A process as claimed in claim 1, in which said composition comprises a composition which has a high gloss surface finish, when dry.

3) A process as claimed in claim 2, in which said composition comprises a gloss intaglio ink.

4) A process as claimed in claim 2, in which said composition comprises an acrylic ink.

5) A process as claimed in claim 2, in which said composition comprises a water-based gravure ink.

6) A process as claimed in any one of claims 2 to 5, in which said composition is applied to said substrate by a printing process.

7) A process as claimed in any preceding claim, in which 3 to 8 grammes per square metre of said composition is applied to said substrate.

8) A process as claimed in any preceding claim, in which said step of impressing said coating of composition makes use of an impression die having a surface relief pattern complementary to the pattern of reflective grooves to be formed in the surface of said composition.

9) A process as claimed in claim 8, in which said impression dies is heated before application to said coating of composition on said substrate.

10) A process as claimed in any preceding claim, in which the aspect ratio of said grooves formed in said coating of opposition is between 1:1 and 20:1.

11) A process as claimed in any preceding claim, in which the spacing between adjacent said grooves is between 2 and 100 microns.

12) A process as claimed in any preceding claim, in which said substrate comprises paper and at least said area of the substrate is super-calendared prior to application of said composition.

13) A process as claimed in any one of claims 1 to 11, in which an initial coating is applied to said area of said substrate and then said composition is applied as a top coating over said initial coating.

14) A process for forming a substrate with an optically variable device, the process comprising applying a composition to said substrate in the form of a pattern of reflective ridges, so as to provide an optically variable image under incident light.

15) A process as claimed in claim 14, in which said composition is of a colour contrasting with the colour of said substrate.

16) A process as claimed in claim 14, in which a background patch is coated onto said substrate, said patch being of different colour or colours from the colour of said substrate, before said composition is applied over said patch in the form of said pattern of reflective ridges.

17) A process as claimed in claim 16, in which said composition is a transparent composition.

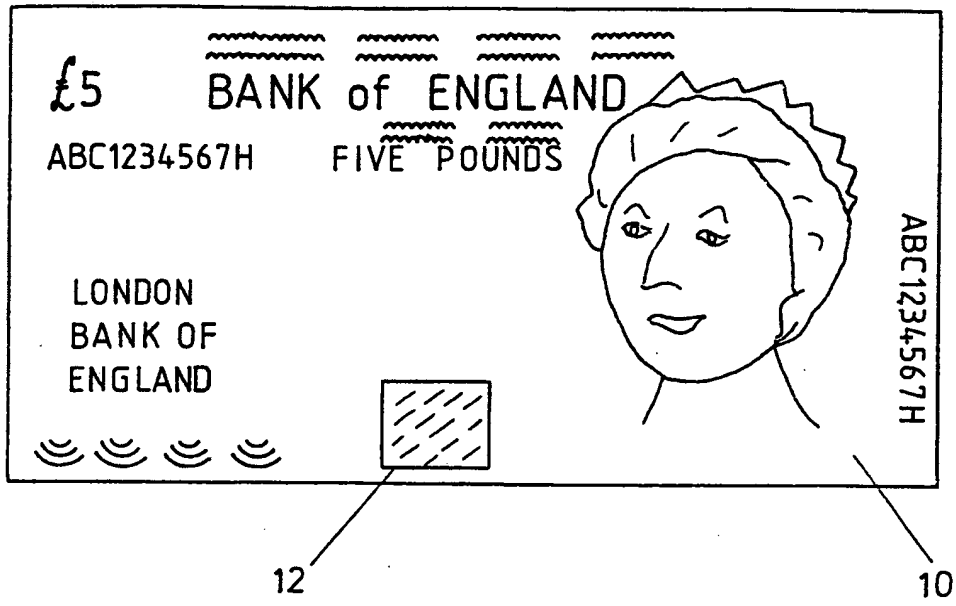

FIG. 1

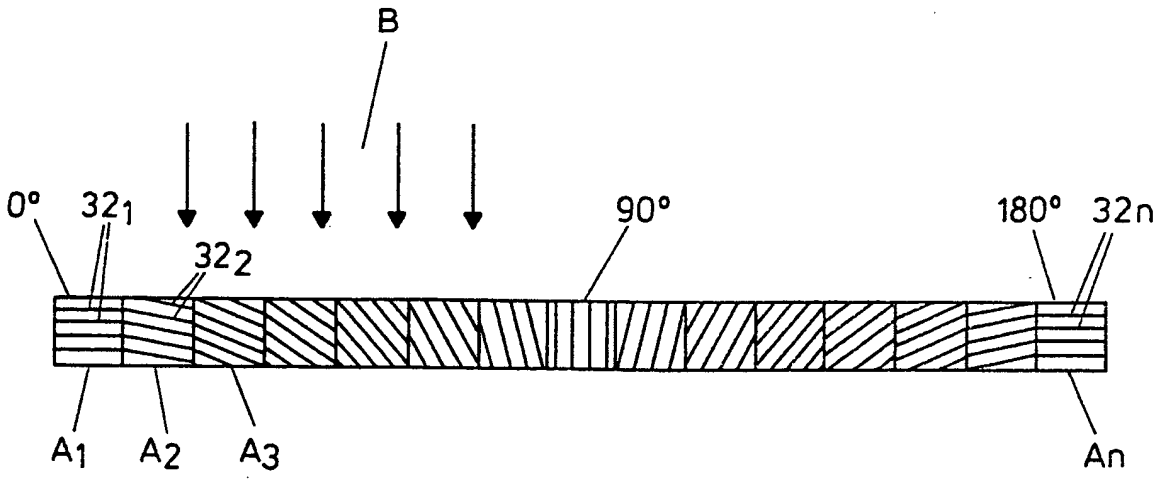

FIG. 4

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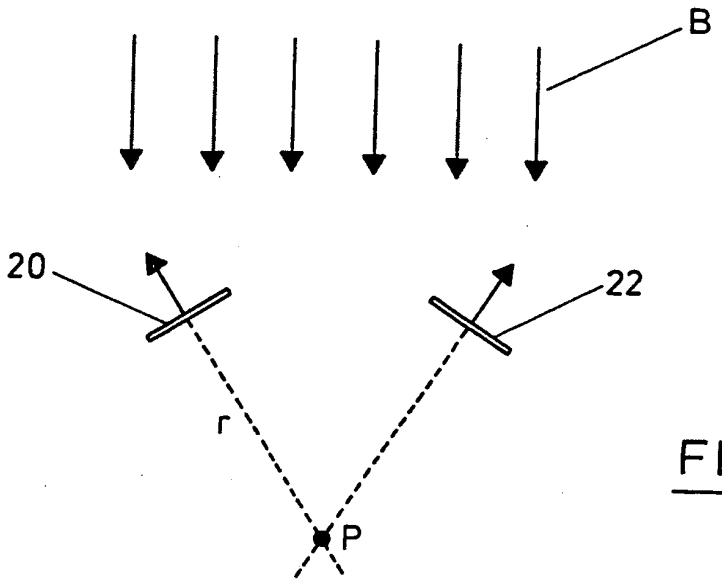

FIG. 2

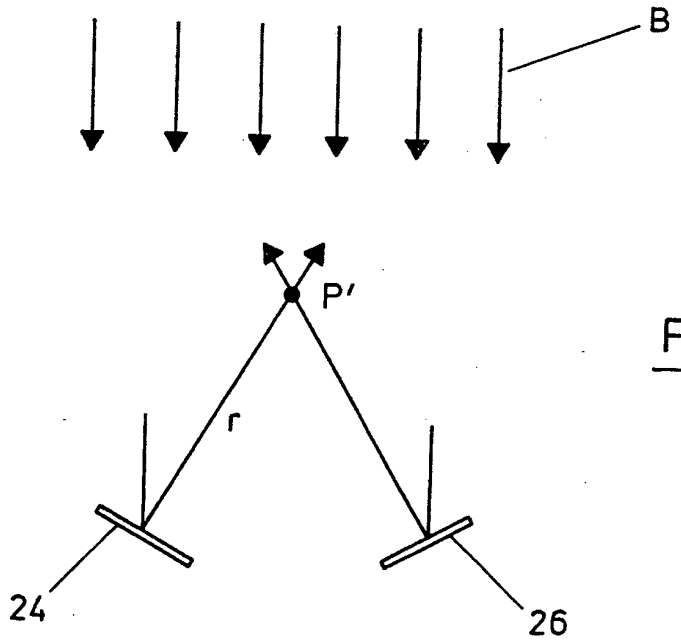

FIG. 3

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INTERNATIONAL SEARCH REPORT

Int tional Application No
PCT/GB 98/01537

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B42D15/00

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B42D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 195 41 064 A (GIESECKE & DEVRIENT) 7 May 1997 see column 2, line 48 - line 59; figures 2,4	1,2,6
X,P	WO 97 34170 A (CHOCK) 18 September 1997 see claim 16	1
X	EP 0 429 782 A (LANDIS & GYR) 5 June 1991 see the whole document	14
A	WO 94 29119 A (RESERVE BANK OF AUSTRALIA) 22 December 1994 see the whole document	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
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Information on patent family members

Int tional Application No
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